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Subject: Root Disease Report for De Motte CG Reconstruction Project, North Kaibab RD

To: Steven E. Martinet, Interdisciplinary Team Leader

Introduction

Although root disease fungi affect conifers throughout the Southwest, they are more active in higher elevation forests like that found in De Motte Campground and surrounding area. Root diseases are believed to have become more prevalent over the past 100 years in areas where nonresinous conifers such as spruce and fir have become dominant over resinous conifers like ponderosa pine, because nonresinous conifers are more susceptible to root decay fungi. Root disease is prevalent in De Motte campground and has caused annual tree failure. Although the district has a hazard tree program in place, tree failure continues to occur because of the magnitude of root rot in this campground. One hazard tree incident resulted in damage to personal property. By definition, a hazard tree is a tree with a defect that gives it a potential to fail and is located where it has the potential to hit a target (people or property).

The purpose of this report is to provide information about the specific root disease pathogens affecting spruce and fir in De Motte campground and provide guidance on mitigation measures that can be applied during site reconstruction.

Affected Environment

The impacts of root disease in De Motte campground were first realized about 15 years ago when the District initiated a hazard tree reduction program, and over 350 trees were removed within a 4-year period. Nearly 7 percent of the tree removals were dead trees (snags), most of which had been killed by root disease, and 30 percent were live trees determined to be unsound and structurally weakened by root decay. Although hazard tree risk was reduced by the District's active program, there have still been incidents of live tree failure, one that resulted in property damage and others that were close calls. Even though many tree failures in this campground have been associated with winter snow loading or a summer microburst, a bigger concern is the live tree failures that occur during relatively mild weather conditions when the campground is open and occupied.

Root disease infection has been observed in De Motte campground from fallen trees, stumps and roots left from hazard tree removal, and the roots of live symptomatic trees. The fungi identified include *Armillaria* spp. and *Inonotus tomentosus* in spruce, *Heterobasidion annosum* in subalpine fir, and *Phaeolus schweinitzii* in Douglas fir. Armillaria root rot is by far the most prevalent root disease observed in stumps (Figure 1) and fallen trees (Figures 2 and 3). Live trees with symptoms of root disease infection are found throughout the campground (Figure 4). In 1991, the forests surrounding the campground were also surveyed; and the same root diseases were found to be prevalent.

Figure 1. Stumps in De Motte campground often show evidence of internal root decay.

Figure 2. Every year a few live trees fail in De Motte campground due to root disease.

Figure 3. Decay and mycelium of *Armillaria* spp.

Figure 4. Crown thinning and dieback due to root disease in De Motte Campground.

Biology and Affects of Root Rots

Armillaria and other root decay fungi quickly invade the root systems of infected trees when they are cut or killed. Although root disease fungi can infect by means of windborne spores on fresh stumps or basal wounds, they more commonly infect via root contacts. The pathogens survive for decades as saprophytes on woody tissues of stumps and snags, which act as a food base. Spread occurs when healthy roots contact decayed roots, or, in the case of armillaria root disease, through root-like structures (rhizomorphs) that grow through the soil for short distances and penetrate root bark[1].

Root decay fungi attack the roots and root collar of trees of all ages, killing the cambium and inner bark and causing a decay of both sapwood and heartwood. Rapid death occurs when the fungus advances quickly through the inner bark and girdles the root collar. Root diseases typically persist on a site for decades by surviving in roots of stumps or snags [2] and on infected roots of live trees. They slowly spread outward in all directions, resulting in a slowly enlarging group of dying and dead trees. The oldest kills are located at the center of infection, with a fringe of recently killed and dying trees around the outer edge.

The aboveground symptoms of trees affected by root disease are chlorosis, reduced needle length, progressive thinning of foliage, fading crown, reduced tree growth, and death. These symptoms are similar to those caused by drought, high water table, and bark beetle attack. However, the decline of trees affected by root disease usually extends over a period of a few to several years and not all trees succumb at the same time. The other causes of decline kill trees more rapidly, generally in one to two years; and a group of trees all die at the same time.

Root disease can significantly alter stand structure and composition through time. Infection by root diseases results in reduced growth, increased mortality (often by bark beetle attack), altered stand structure, and, sometimes, large openings in forests. Some root diseases can kill young trees rapidly (especially trees planted off-site); but others slowly decay the roots and rob the trees of water, nutrients and structural support. They are called “diseases of the site,” because they survive extended periods of time in woody material such as stumps or snags. Infection centers are typically around these infected stumps and snags, which are acting as a food base for the fungus, and vary in size from groups of a few trees to patches of tens of acres.

The ability of root disease fungi to kill trees is greatly influenced by host vigor. Root disease fungi are often aggressive in young stands less than 30 years old, especially when large stumps or snags harbor the fungus. Advance of the fungus is much slower in older, rapidly growing trees in which resin secretion and callus formation blocks spread of the disease.

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[1] Shaw III, D.G., and G.A. Kile. 1991. Armillaria root diseases. USDA Forest Service Agricultural Handbook 691. 233 pp.

[2] Tkacz, B.M. and F.A. Baker. 1991. Survival of Inonotus tomentosus in spruce stumps after logging. Plant Disease 75:788-790.

Trees affected by root disease are often predisposed to attack by bark beetles. Researchers have found an association between endemic levels of bark beetles and root disease [3] [4] [5] and with a beetle population increase when combined with a short-term drought [6].

Environmental Consequences of the Proposed Action

The management strategies outlined in the proposed action include activities to reduce the impact of root disease infection and the current level of hazard tree risk within De Motte campground. Treatment options include: Minimizing the number of root disease infected trees (hazard trees) by removing all spruce and subalpine fir over 12 inches DBH; reducing the food base of the fungus by removing stumps during site reconstruction; reforesting with less susceptible conifers; and maintaining vigorous tree growth. These actions will help reduce the risk of injury to people and their property, damage to site structures, and the level of root disease infection to regeneration.

The no action alternative would mean a continued elevated risk of injury to people and their property, since root disease infected trees will continue to fail.

If you have any questions about this report please, call me at (928) 556-2075 or email mfairweather@fs.fed.us.

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[3] Tkacz, B., and Schmitz, R.F. 1986. Association of an endemic mountain pine beetle population with lodgepole pine infected by Armillaria root disease in Utah. USDA For. Serv. Res. Note INT-353.
[4] Hadfield, J.S. 1985. Laminated root rot, a guide for reducing and preventing losses in Oregon and Washington forests. USDA Forest Service Pacific Northwest Region, Portland, Oreg.
[5] Hadfield, J.S.; Goheen, D.J.: Filip, G.M.; [and others]. 1986. Root diseases in Oregon and Washington conifers. R6-FMP-250-86. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Forest Pest Management. 27p.
[6] Cobb, F.W. 1989. Interactions among root disease pathogens and bark beetle conifer forests. *In* Proceedings of the 7th IUFRO Conference on Root and Butt Rots, Vernon and Victoria, B.C. *Edited by* D.J. Morrison. Forestry Canada, Pacific Forestry Centre, Victoria, B.C.